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LABORATORY

RELIABILITY AND MAINTAINABILITY (R&M)

Robert J. Hankins

Integrated Support Systems, Inc.
100 McCollum Street
Clemson, South Carolina 29631

LOGISTICS AND HUMAN FACTORS DIVISION
Wright-Patterson Air Force Base, Ohio 45433-6503

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JOHN IANNI
Contract Monitor

BERTRAM W. CREAM, Technical Director
Logistics and Human Factors Division

DONALD C. TETMEYER, Colonel, USAF
Chief, Logistics and Human Factors Division

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Clemson, South Carolina 29631

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This paper details an Air Force Reliability and Maintainability (R&M) study which investigated the degree to which R&M logistics analyses requirements are satisfied by the Unified Data Base (UDB) for Logistics Information, a fully automated on-line interactive Logistic Support Analysis Record system. The R&M study consisted of three sequential tasks: (a) investigation and definition of requirements, (b) definition of the frequency and method of specific R&M data collection, and (c) performance of comparability analyses of data elements defined in the first task and currently in the UDB. This paper includes a detailed description of the procedures followed and results of each task and provides recommendations for incorporation into the UDB.

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Nancy J. Allin, Chief, STINFO Office

22b. TELEPHONE (Include Area Code)
(512) 536-3877

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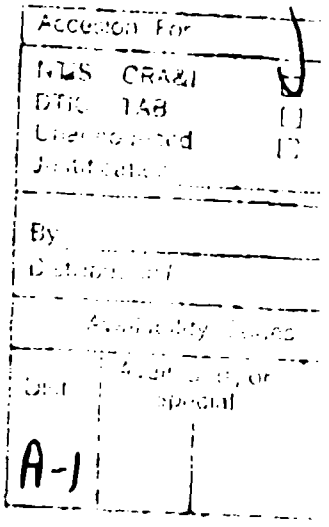
Robert J. Hankins

Integrated Support Systems, Inc.
100 McCollum Street
Clemson, South Carolina 29631

LOGISTICS AND HUMAN FACTORS DIVISION
Wright-Patterson Air Force Base, Ohio 45433-6503



Reviewed by

Joseph W. Coleman, Lt Col, USAF
Chief, Acquisition Logistics Branch

Submitted for publication by

Bertram W. Cream, Technical Director
Logistics and Human Factors Division

This publication is primarily a working paper. It is published solely to document work performed.

SUMMARY

The present effort was designed to accomplish the following tasks: (a) Investigate and define Reliability and Maintainability (R&M) analysis, documentation and tracking; (b) Define the frequency and method of specific R&M data collection; (c) Perform comparability analysis of data elements defined in Task 1 and data elements currently in the Unified Data Base (UDB 2000); and (d) Prepare a final report covering the results and findings of each task.

The investigation and definition of requirements in Task 1 were accomplished through research of applicable directives and through personal contact with Offices of Primary Responsibility (OPRs). The results of this task are addressed in detail with examples provided in the form of an R&M Program Audit Trail chart and a Reliability Management chart.

The frequency and method of specific R&M data collection (Task 2) are then discussed. Primarily, it was found that the frequency of R&M data collection is acquisition program dependent, as is the requirement for the capability to assess the R&M program status. Reports on program status are required on demand, as determined by the acquisition program manager. Data collection after fielding will be required in a near-real-time mode for the proposed Reliability and Maintainability Information System (REMIS).

A comparison of the data elements required and the data elements currently in the UDB 2000 was accomplished in Task 3. Results of this task show that although some of the elements are currently in the UDB 2000, they are not in the form needed to satisfy the requirements for tracking. The elements currently in UDB 2000 are not time/phase-related, as is necessary to satisfy the requirements identified in Task 1.

The authors identify additional data elements, screens, and reports that should be incorporated into UDB 2000. They also recommend that an interface between UDB 2000 and REMIS be incorporated into the REMIS development effort. Finally, it is also recommended that an Air Force policy decision on the retention, use, and method of storing Logistic Support Analysis Record (LSAR) data after fielding be obtained as soon as possible.

PREFACE

This work was initiated by the Logistics and Human Factors Division, Air Force Human Resources Laboratory, Wright-Patterson Air Force Base, Ohio, under Project 2940. The Work Unit was 2940-04-01, Unified Data Base (UDB) for Logistics Information.

Appreciation is extended to LTC Joseph W Coleman of the Acquisition Logistics Branch of AFHRL for his guidance and encouragement throughout this effort. Appreciation is also extended to the many individuals of Air Force Acquisition Logistics Center at Wright-Patterson Air Force Base, Ohio, who supplied information in support of this study.

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1.0 INTRODUCTION

Background

The Department of Defense (DoD) is placing increasing emphasis on Reliability and Maintainability (R&M), due to the ever-increasing costs associated with the operation and support of new weapon systems. Consequently, procedures for monitoring and tracking Reliability, Availability, and Maintainability (RAM) parameters were developed and published in AFR 800-18, Air Force Reliability and Maintainability Program, dated 15 June 1982. This regulation establishes Air Force policy relative to the management and control of an R&M Program for each weapon system acquisition and major modification program. Independent reviews of major defense system acquisition programs (see AFR 800-5) will be made to assess the adequacy of the R&M program.

The present effort addresses the method of collecting, storing, retrieving, and presenting the results of these assessments throughout the life cycle of the system/equipment. The term R&M includes availability and readiness as defined in AFR 800-18. Air Force Logistics Command (AFLC) Supplement 1 to AFR 800-18, dated 10 May 1983, further defines the specific responsibilities of AFLC with respect to R&M program management during the acquisition phase and after fielding of the system/equipment.

The results of a preliminary analysis were previously submitted on 17 May 1985. Additional research and analysis were conducted to verify the findings of the preliminary analysis and to expand the investigation to additional sources of information.

There is a need for R&M tracking in three distinct areas. One is for the contractor's predictions in meeting the R&M requirements imposed by the Government agency procuring the system/equipment. The second is for program management during development, and the third is continued tracking after fielding of the system/equipment. In addition, there is a need to track Availability (A) as well as R&M. Therefore, this study addresses R&M and A (commonly referred to as RAM parameters).

Tasks To Be Performed

The R&M Study consisted of four sequential tasks as identified below:

Task 1 - Investigate and define the requirements for R&M analysis, documentation, and tracking throughout the weapon system development cycle, based on MIL-STD-1692A, MIL-STD-785, MIL-STD-470, MIL-STD-1388-1A, AFR 800-18, and other sources.

Offices of Primary Responsibility (OPRs) for the various MIL-STDs will be contacted for the purpose of determining the extent to which anticipated changes to the MIL-STDs would impact the R&M community.

Task 2 - Define the frequency and method of specific R&M data collection throughout the acquisition cycle of a weapon system. Define the method of historical R&M data storage, data management, and data retrieval. Define and justify specific output reports and frequency of reports required throughout the acquisition cycle of a weapon system for R&M tracking purposes. Coordinate findings and recommendations with appropriate Air Force offices responsible for R&M data collection, storage, reporting, and tracking.

Task 3 - Perform comparability analysis of R&M data element requirements covered in Task 1, and the data elements currently in the Unified Data Base (UDB) 2000 system. Recommend and justify the additional data elements needed to satisfy the R&M requirements identified in Task 1.

Task 4 - Prepare a final report covering the results and findings of Tasks 1, 2, and 3, and provide specific and detailed recommendations and justification for additional outputs, frequency of data collection, and historical storage methods, with supporting rationale for enhancements to the UDB system to satisfy R&M data collection, data storage/management, and reporting requirements.

Purpose

The purpose of the present investigation was to determine the degree to which R&M logistics analysis requirements are satisfied by the UDB 2000 system data elements and outputs, and to recommend additional UDB 2000 data elements and outputs to satisfy these requirements if necessary.

2.0 TASK 1. INVESTIGATE AND DEFINE REQUIREMENTS

Contractor Predictions/Allocations

The first need addressed can be satisfied by the R&M Tracking Report previously defined for the UDB 2000 and for which the specifications have been provided. The second need is the subject of this paper and will be addressed in detail, along with appropriate conclusions and recommendations for incorporating the additional data elements into the UDB 2000 database, interfacing with the developing Reliability and Maintainability Information System (REMIS), and reports/output to satisfy the requirements identified.

R&M Tracking Requirements at the Program Management Level

The program management requirements were derived from personal discussions with the individuals responsible for providing the information to the program managers (PMs) and information obtained during these contacts in the form of data formats, data elements, and reference material. The individuals contacted were extremely cooperative in providing the information requested and offered a number of comments and suggestions which were valuable in reaching the final conclusions and recommendations.

Appendices A and B were provided by the Aeronautical Systems Division (ASD/EN-PA). Appendices C and D were provided by the Air Force Acquisition Logistics Center (AFALC/ERR).

The purpose of the R&M Program Audit Trail (Appendix A) and the Reliability Management Chart (Appendix B) is to provide the AFALC Commander, the Management Air Logistics Center (ALC) Commander, and the AFLC Commander with the periodic assessment of the R&M Status of Defense System Acquisition Review Council (DSARC), Program Assessment Review (PAR), and Special Program Requirements (SPR) Programs (Reference AFLC Supplement 1 to AFR 800-18, paragraph 11.1g(1), and 11.1h(7)).

The R&M Program Audit Trail (Appendix A) identifies the format and three categories of R&M data elements to be tracked:

- Mean Time Between Maintenance (MTBM)
- Maintenance Manhours Per Flight Hour - Organization Level (MMH/FH - Org Level)
- Full Mission Capable (FMC)

It should be noted that this format differs slightly from the one provided at the time the initial preliminary analysis was performed. The difference is in the data elements for the "Predecessor," where only the "User Requirement" and "Field Value" for all three categories are required. The elements for the "New" are the same as those previously identified. These elements are as follows:

- User Requirement (USER RQMT)
- Program Management Directive Value (PMD VALUE)
- Contract Requirement (CONT RQMT)
- Projected Value (PROJ VALUE)
- Demonstrated/Tested Value (DEMO/TESTED VALUE)
- Field Value (FIELD VALUE)
- Program Management Assessment (PM ASSESS)

These elements apply to all three categories to be tracked.

The Reliability Management chart (Appendix B) identifies the "Reliability Management" data elements and format. The complete list of data elements needed to construct this chart is as follows:

- Acquisition Phase (ACQ Phase)
- Concept (By Calendar Year - CY and Date)
- Demo/Val (By Calendar Year - CY and Date)
- Full Scale Development (FSD) (By Calendar Year - CY and Date
- Production (By Calendar Year - CY and Date)
- * Cumulative Test Time (Flight Hours) By Date and Type Test
- Start Testing (By Date and Type)
- Critical Design Review (CDR) - (By Date)
- First Flight (By Date)
- Production Decision (By Date)
- Initial Operational Capability (IOC) - (By Date)
- Threshold Values (AFSARC, DSARC, etc.)
- Predicted Values
- Contractural Requirement
- Planned Growth (By Time/Date relationship)
- Projected Growth (By Time/Date relationship)

* Cumulative Test Time must identify the type of test (Reliability Qualification Test (RQT), Flight Test, etc.).

This particular format is obviously for aircraft. Some of the elements would need to be redefined if this same capability were to be applied to equipments other than aircraft. For example, "First Flight" would not be applicable to Ground Communications or Support Equipment, nor would Cumulative Test Time be in flight hours. Therefore, the definitions for these fields would need to be keyed to the type of equipment in order for the output to be of a generic nature. This would also be true for the Appendix A format, particularly as it relates to Full Mission Capable (FMC).

Continued Tracking After Fielding to Maturity

Appendix C identifies a method of tracking reliability at the component level (Line Replaceable Unit (LRU)/Shop Replaceable Unit (SRU)). This method combines the results of Optimum Repair Level Analysis (ORLA), the AFLC Recoverable Consumption Item Requirements System (D041) data, and AFM 66-1, Maintenance Data Collection (MDC) - (field data) and utilizes regression analysis techniques. The D041 System is not one of the systems to be replaced by REMIS; therefore, it must be assumed that the D041 System will continue to be a stand-alone system. In addition, the REMIS is to incorporate a regression analysis capability which is not inherent in the UDB 2000 database (Reference REMIS Request for Proposal (RFP), paragraph 2.2.2 General System

Objectives, subparagraph k). This is definitely a needed tracking capability but appears to be more appropriate for inclusion in the REMIS development than in UDB 2000. This type of tracking relates to fielded systems, in that the projections are based on the failure data reported through the field data reporting systems. However, there should be provisions for updating the Logistic Support Analysis Record (LSAR) database(s) with the results of this analysis (Mean Time Between Removal (MTBR) and Maintenance factor (MF)). This is essential if the LSAR is to be utilized as a validated historical record to support future acquisitions in terms of comparability analysis of the same or similar components.

Appendix D provides the basis for projecting the reliability growth at the component level and is related to Appendix C.

3.0 TASK 2. DEFINE FREQUENCY AND METHOD OF R&M DATA COLLECTION, STORAGE, MANAGEMENT, AND RETRIEVAL

Requirements For Assessment

The document that specifically establishes the requirement for R&M Tracking/Audit Trail is AFR 800-18, as supplemented by AFLC Supplement 1, dated 10 May 1983; it establishes the frequency of reporting requirements (Reference Paragraph 11.1, g(1) and paragraph 11.1, h(7) of AFLC Supplement 1). These reviews will be scheduled independently for each program. However, there is a specific requirement for a quarterly Program Assessment Review (PAR) utilizing the format in Attachment 4 to AFR 800-18 for fielded systems (RCS: HAF-LEY(AR) 7904). The sources for these data are System Availability (Q-D056T-B31) and Standard R&M Data Products (Q-D956T-B34) which support preparation of these assessments.

Data Storage, Management, and Retrieval

The proposed screen layouts and output report formats for the R&M Program Audit Trail data and the Reliability Management Chart data are contained in Appendix E. The screen layouts are not divided into R&M Program Audit Trail data screens since so much of the data is duplicated between the two reports. The first two screens contain single-entry data and data that are not required to be tracked by Date/Phase relationship. The remaining screens are designed to allow multiple entries by Phase, Type of Test, and Date. The output report formats, on the other hand, are divided into R&M Program Audit Trail data and Reliability Management Chart data. This provides for a separate output report containing only the required data to construct each chart (R&M Program Audit Trail Chart and Reliability Management Chart).

4.0 TASK 3. PERFORM COMPARABILITY ANALYSIS

Data Elements Not Currently in UDB 2000

The parameters identified for the R&M Audit Trail (Appendix B) are not currently in the UDB 2000 in the form needed for this purpose. "Predicted" and "Measured" values are in the UDB 2000 but are not time/phase-related. As defined in MIL-STD-1388-2A, these values are the projected "mature" values and, therefore, will not satisfy the requirements for the R&M Audit Trail. These values would serve only as the "Projected" or "Goal" values to be achieved at maturity, which is normally considered to be 2 years after IOC.

Data Elements Required For Tracking

Appendices A and B identify the parameters which were identified by the OPRs as required for R&M Audit Trail and Reliability Management according to AFR 800-18, as supplemented by AFLC Supplement 1. The LSAR data records currently defined by MIL-STD-1388-2A do contain the System End Item Mean Time Between Failures (MTBFs) in terms of "Minimum Acceptable" and "Best Operational Capability" as requirements. The contractor's "Predicted" MTBF is also provided in the LSAR B data record along with the "Growth Rate." This cannot be related to cumulative test time/phase and will not satisfy the need for tracking. The proposed data record screen formats and report output formats presented in Appendix E will allow the data to be stored/retrieved by cumulative time/phase relationship. This will provide the data in the form required to construct the charts.

5.0 RELIABILITY AND MAINTAINABILITY INFORMATION SYSTEM (REMIS)

Interface

A comprehensive search of the interfacing systems identified in the REMIS RFP failed to identify an interface with the UDB 2000. However, the RFP states under paragraph 2.4.1.2, titled "Product Performance Subsystem," implementation of this subsystem is anticipated to provide:

> "cradle-to-grave R&M Tracking via on-line access to LSAR data containing original R&M design specifications and performance parameters."

This provision would appear to imply that LSAR data will be accessible on-line as a part of the REMIS development. However, paragraph 2.2.3, Process Objectives, subparagraph g indicates that the system will:

"provide the capability to receive and store predictions of initial (Minimum Acceptable Value) and mature (Best Operational Capability) R&M parameters (provided from Logistics Support Analysis (LSA) records or another source) and to project the planned growth of these parameters to their maturity."

This statement appears to be in conflict with the previous statement. Therefore, it is unclear as to exactly what the objective of REMIS is in relation to LSAR data. If the LSAR database is to be a part of REMIS, it will require duplication of the data contained in the LSAR. It should be further pointed out that the "Minimum Acceptable Value" and "Best Operational Capability" values are LSAR Data Record A, Operation and Maintenance Requirements. This information is provided by the Government to the contractor as requirements, not predictions. The contractor may use the LSAR Data Record A to "Allocate" these requirements to lower indenture levels.

R&M predictions are recorded on the LSAR Data Record B, Item Reliability (R) and Maintainability (M) characteristics. This data record provides the capability to record "Comparability," "Allocated," "Predicted," and "Measured" values. It does not identify the parameters in terms of "Minimum Acceptable Value" or "Best Operational Capability." There is a need to address both sets of data for tracking purposes. This is discussed in more detail under program requirements.

If paragraph 2.2.3, subparagraph g, of the REMIS RFP, is to be a part of the REMIS development, there is definitely duplication of effort in the development of an R&M tracking capability in the UDB 2000. There is no question that REMIS will be the logical source for the R&M parameters to be tracked after fielding (measured values). The question is: Will the LSAR be updated with the measured values provided from REMIS? If an R&M Tracking capability is developed for the UDB 2000, updating the measured values will be essential to this development.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Air Force Policy on Retention of LSAR Not Clear

There appears to be some question as to the Air Force policy relative to the retention and use of LSAR data beyond the acquisition phase. It is recommended that Systems and Applied Sciences Corporation (SASC), through their role in the REMIS development, recommend an interface between REMIS and UDB 2000 as a part of the REMIS development.

Interface With REMIS Needed

If this interface were established, a much-improved RAM and Reliability Growth projection capability would be possible. Since REMIS is to incorporate both a graphics and regression analysis capability (Reference REMIS RFP paragraph 2.2.2, General System Objectives, subparagraph k), the charts shown in both Appendices could be produced on-line, using the UDB 2000 database as the source data.

Appendix C could also be produced on-line for a given LRU/SRU, or produced in a batch mode when multiple LRUs/SRUs are involved. The UDB 2000 will not be the source for these data but an interface between REMIS and UDB 2000 will allow the UDB 2000 LSA records to be updated from REMIS. This update should occur each time the report for a given LRU/SRU is produced.

Appendix E identifies the data elements, screen layouts, and data element descriptions for those data elements to be added to the UDB 2000 database. The frequency of update should occur prior to producing the report. The frequency of report production depends upon specific program requirements; however, it would be produced on demand.

Appendix E also includes a recommended hard-copy report output which will provide the capability to manually construct the charts shown in Appendices A and B until such time that REMIS is operational. This is recommended as an interim measure only.

Although the incorporation of the recommended additions to the UDB 2000 will provide RAM tracking capability for programs utilizing UDB 2000, the same capability will not be available for programs not utilizing UDB 2000. Therefore, a recommendation for developing this capability is not possible until such time that the Air Force establishes policy relative to retention of LSAR data and how and where these data will be stored.

Areas To Be Tracked

There are three distinct areas that need to be addressed in terms of RAM tracking. These are:

- Contractor Tracking of Predictions versus Allocations
- Program Management Tracking and Projections to Maturity
- Operational Systems Tracking (Fielded Systems) throughout the life cycle of the system/equipment

Contractor Tracking of Predictions Versus Allocations

The contractor's tracking of predictions versus allocations is essential to ensuring the program requirements are being achieved. This capability was previously defined for UDB 2000, and the specifications were furnished. The contractor is

normally required to use the top-level RAM parameters provided by the Government, and to allocate these down to the lower indenture levels. The predictions are aggregated from the bottom up and compared to the allocations at intermediate levels to ensure predictions are not exceeding allocations. The reports identify any values that exceed those allocated based upon the current status of the LSAR database; that is, everything that has been identified to the database at the time the report is produced. This report may be used to assist in the development of the charts depicted by Appendices A and B at each Contractor's Assessment Review (CAR). This report also serves as the source for the time/phase-related data elements which are input utilizing the proposed screens depicted by Appendix E. This provides the capability of tracking over time as the weapon system evolves, is produced, and is deployed as an operational system.

Program Management Tracking

The R&M Audit Trail (Appendix A) and the Reliability Management Chart (Appendix B) were provided by the Office of Primary Responsibility (ASD - Office Symbol EN-PA) as the format and data elements required to satisfy the requirements of AFR 800-18 and AFLC Supplement 1. This format is applicable throughout the acquisition cycle. The data elements identified in the screen layouts depicted in Appendix E relate directly to the data elements identified in Appendices A and B, and would be used to track the RAM parameters to "maturity" as defined by the program manager; they would apply to major modification programs.

Operational System Tracking

Operational system tracking throughout the life cycle of the system/equipment is reported through the field data reporting systems in the format prescribed in Attachment 4, AFR 800-18, under Reports Control Symbol (RCS): HAF-LEY(AR) 7904. These reports address RAM parameters on operational (fielded) systems/equipment. The information contained in these reports would be the source for updating the LSAR database with measured values for use in support of future acquisition programs.

The data elements identified for tracking for program management and operational system tracking are not inherent in the MIL-STD-1388-2A LSAR. For example, Full Mission Capable (FMC) is one of the elements to be tracked for program management. The LSAR identifies availability only in terms of "Inherent Availability (Ai)," "Achieved Availability (Aa)," and "Operational Availability (Ao)." In our research, we were unable to find any definition that relates either of these elements to FMC.

The REMIS RFP is not clear as to the Air Force policy relative to the retention of the LSAR data after fielding. If the UDB 2000 database is expanded to incorporate the additional data elements, this will still leave a void in the data system for acquisitions that do not use UDB 2000. Assuming that the required interface with REMIS is incorporated, there is the problem of where the data will be stored for those systems not using UDB 2000. This would appear to be essential to consistency in tracking capability.

APPENDIX A: R&M PROGRAM AUDIT TRAIL

RELIABILITY & MAINTAINABILITY PROGRAM

AUDIT TRAIL

	USER RQMT	PMD VALUE	CONT RQMT	PROJ VALUE	DEMO/ TESTED VALUE	FIELD VALUE	PM ASSESS
(NEW)	6.5	6.2	12 MTBF	8 MTBF	3.6 MTBF	N/A	
(PRED)	2.0					1.5	

MTBM

	USER RQMT	PMD VALUE	CONT RQMT	PROJ VALUE	DEMO/ TESTED VALUE	FIELD VALUE	PM ASSESS
(NEW)	20	20	20	22	N/A	N/A	
(PRED)	25					16	

MMH/FH (ORG LEVEL)

	USER RQMT	PMD VALUE	CONT RQMT	PROJ VALUE	DEMO/ TESTED VALUE	FIELD VALUE	PM ASSESS
(NEW)	95	95	95	95*	*	N/A	
(PRED)	90					75	

FMC

Green

Yellow

Red

TITLE: RELIABILITY AND MAINTAINABILITY PROGRAM AUDIT TRAIL

REQUIREMENT: Mandatory chart for CAR/PAR/SPR briefings.

PURPOSE: To portray and monitor critical R&M parameters and the relationship between user needs, program direction, contract requirements, demonstrated/tested/projected values, and field performance.

INSTRUCTIONS:

1. The format will be an audit trail between the user needs, program direction, projected value, demonstrated/tested value, and field performance. The audit trail will be shown for the new system and for a predecessor defined as an operational system which is most similar to the new system and will be used for historical comparison. If no suitable predecessor system exists so state.

a. User need. Normally stated in the SON. (New and predecessor.)

b. Program management direction. The value that is contained in the program direction document (normally the PMD). If different from the user requirement explain why. (New system only.)

c. Contractual requirement. The specification or contractual value. If measured differently than the first two values indicate and be prepared to explain. (New system only.)

d. Projected value. The PM's assessment of the value that will be attained at maturity (define maturity). Explain basis of projection. Parameters will be consistent with the contractual requirement. (New system only.)

e. Demonstrated/tested value. This value, with parameters to be consistent with the contractual value, will be based on actual demonstration/test data. The data may be from development test, a reliability growth development test, a MIL-STD 781 test, a maintainability demonstration, or a combination thereof. The PM must be prepared to explain the source of the data (New system only.)

f. Field value. This will be the value, measured in operational terms, based on IOT&E/OT&E and/or actual field use. (New and predecessor.)

g. Program Manager's Assessment. This block will be color coded using the following guidelines which are intended to aid the program manager in making an assessment of the audit trail parameters.

(1) Each audit trail parameter will have its own program manager's assessment and will be rated as follows:

(a) Satisfactory (green). Satisfactory indicates that the contractual requirement, projected value, and any measured value (demonstrated, tested, and/or field value) meet the user/PMD requirement.

(b) Marginal (yellow). Marginal indicates an existing problem for which there is some question whether the contractual requirement, projected value, or any measured value meet the user/PMD requirement. However, the problem appears to be within the program office's or product division's ability to solve and an action plan is underway to solve the problem.

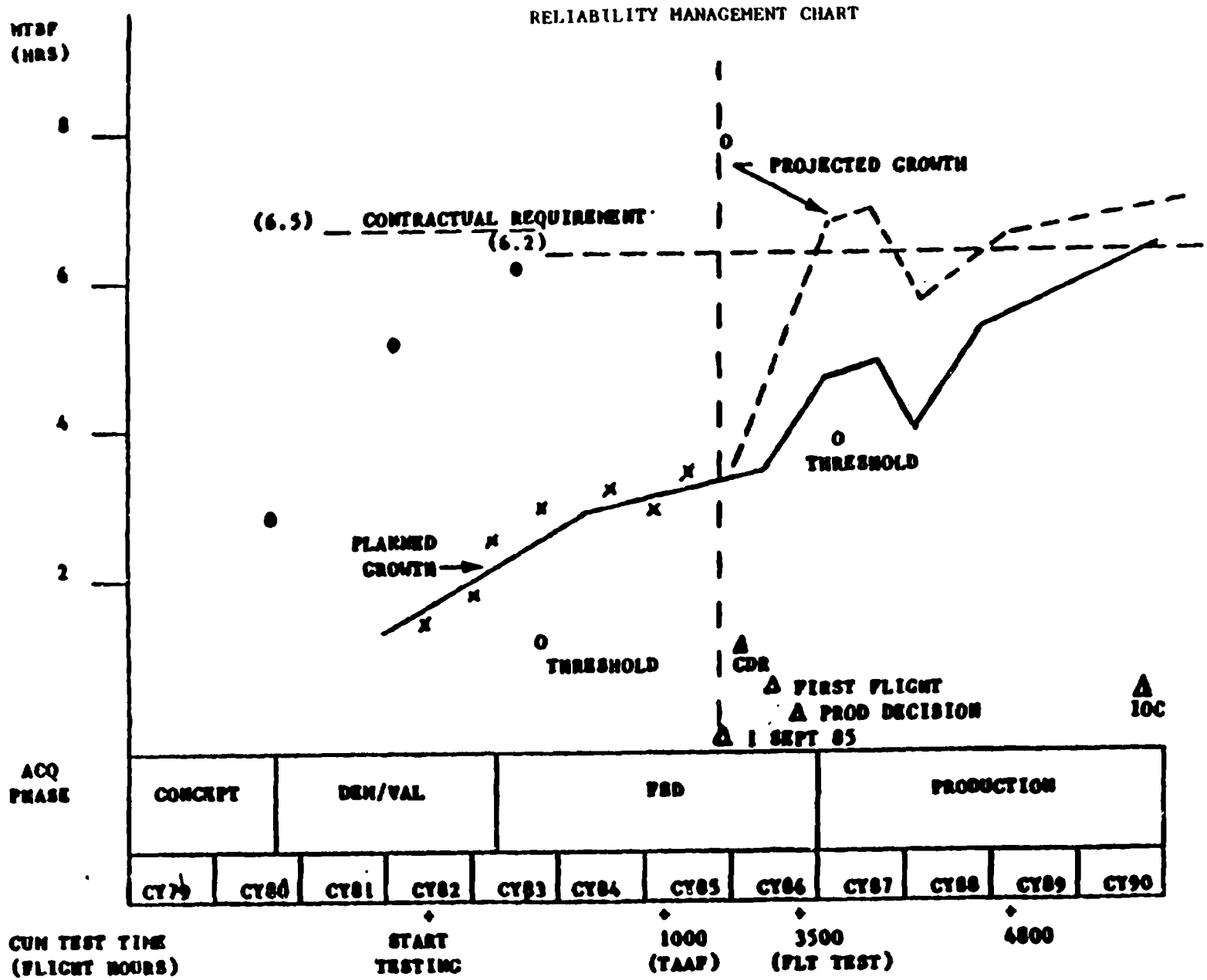
(c) Unsatisfactory (red). Unsatisfactory indicates a serious problem exists in which the contractual requirement, projected value or any measured value will not meet the user/PMD requirement and requires the assistance of HQ AFSC and/or HQ USAF for resolution.

(2) The program manager should be prepared to address rationale for the assessment of each parameter.

2. As a minimum, a matrix will be shown for each critical R&M parameter stated in a program direction. If a particular value for a given box is not available enter NA; if the box is not applicable enter N/A. (Note that the R&M parameters and values shown are for illustrative purposes only. The PM must select the parameters from attachment 1 of AFR 800-18 that are critical for his/her program.)

3. In the example asterisks are entered in three boxes of the FMC matrix indicating further explanation is needed. In this case FMC is not measured directly but is derived from MTBM and MMH/FH. The PM must be prepared to discuss such "exceptions."

APPENDIX B: RELIABILITY MANAGEMENT CHART


RELIABILITY MANAGEMENT CHART
MTBF (HRS)
8
6
4
2
(6.5) CONTRACTUAL REQUIREMENT
(6.2)
PROJECTED GROWTH
PLANNED GROWTH
THRESHOLD
THRESHOLD
CDR
FIRST FLIGHT
PROD DECISION
1 SEPT 85
IOC
ACQ PHASE
CONCEPT
DEM/VAL
FSD
PRODUCTION
CY79
CY80
CY81
CY82
CY83
CY84
CY85
CY86
CY87
CY88
CY89
CY90
CUM TEST TIME (FLIGHT HOURS)
START TESTING
1000 (TAAF)
3500 (FLT TEST)
4800
LEGEND:
PREDICTED VALUE (MIL-STD-756)

TITLE: RELIABILITY MANAGEMENT CHART

REQUIREMENT: Mandatory chart for CAR/PAR/SPR briefings.

PURPOSE: To illustrate how the reliability program is being managed to achieve the mature requirement, to show the relationship between key factors and/or phases of the reliability program, and to track progress in meeting the mature requirement.

INSTRUCTIONS: The critical reliability parameter (e.g., MTBF) will be plotted on the vertical axis using the proper life units (e.g., cycles, rounds, hours). Along the horizontal axis the acquisition phase and calendar time will be shown. Below the calendar time the cumulative test life units will be shown.

1. A dotted horizontal line will be used to indicate the contractual requirement with the actual value in parentheses.

2. A dotted vertical line will be used to indicate the "today" point on the chart.

3. The chart should depict where the PM "plans to be" at any point in time for the reliability parameter. The resulting "curve" should not necessarily be construed to be a reliability growth curve in the strict sense of the term and as described in MIL-HDBK-189, although the PM has the discretion to use such a curve if it is appropriate for the program.

4. Indicate with solid bullets the predicted value (or projected value if MIL-STD-756 is not used. In this case be prepared to discuss the basis for the projection).

5. Indicate with an "x" values of the parameter based on test results. Below the calendar time indicate the type of test (TAAF, RQT, flight test, etc.) and test hours.

6. Indicate threshold (DSARC, AFSARC, etc.) values with circles.

7. Show key milestones, such as CDR and IOC. For clarity omit milestones that predate the briefing date.

8. Show the projected "Growth" (if different from planned) and explain variances. In the example the planned "growth" accounted for expected learning during the transition from design to production and showed the contractual requirement being achieved at IOC. The projected curve shows a jump because a new technology, not mature when the program was initiated, was approved at CDR and will be implemented prior to production decision. The PM must be prepared to discuss such "anomalies" as well as other implicit details (e.g., number of test articles, number of unincorporated design fixes, definition of failure, etc.).

9. The contractual value, in this example, was decreased slightly based on the results of dem/val. The Reliability and Maintainability Program Chart will show how the current contractual value is related to the operational need.

APPENDIX C: RELIABILITY GROWTH AT THE COMPONENT LEVEL

RELIABILITY GROWTH

Concept - The successful design, development, testing and production of a new weapon system (such as the F-16) depends greatly upon two resources: time and money. Typically, a contractor is asked to produce a complex weapon system or component thereof in minimum time at minimum expense in a competitive environment. More often than not, the result is a product which has not been sufficiently tested to identify design and manufacturing imperfections. These imperfections manifest themselves as failures - the inability to perform in accordance with specification requirements.

Early in the operational life of the weapon system, the user evaluates the effectiveness of the system through actual use. As failures occur, the user places significant emphasis upon the need for corrective action which will render the item or system acceptable. As a result, the contractor usually becomes motivated to analyze the failures, determine the basic cause of the failures and then effect corrective action in the item, in tech data and/or in SE. The result is an item with improved reliability characteristics or "reliability growth."

Duane Postulate - Quantification of reliability growth was not commonly done until after J. T. Duane recognized a patterned relationship between failure rates and cumulative operating time. The following excerpt from a paper by J. D. Shelby and S.G. Miller, "Reliability Planning and Management (RPM)," briefly explains the "Duane Postulate."

> Origin of Reliability Growth
>
> The basic concept of a patterned reliability growth... was first recognized and published by J. T. Duane of GE Company's Motor and Generator Department in 1962. His analysis of test and operational data for programs with test times as high as 6 million hours on five divergent groups of products (two hydro-mechanical devices, two complex aircraft generators, and a jet engine) formulated a pattern which resulted in the following concept.
>
> a. Reliability improvement of complex equipment follows a mathematically predictable pattern.

b. Reliability improvement is approximately inversely proportional to the square root of cumulative operating (test) time.

$$R(I) \approx \frac{1}{\sqrt{OH}}$$

c. For a constant level of corrective action effort and implementation, reliability growth closely approximates a straight line on a log scale.

This pattern has been confirmed to be applicable to avionics equipment by GE/AES from data on four separate programs. (End of quote)

Initial Provisioning - OO-ALC/MMAR, through the Resident Integrated Logistics Support Activity (RILSA), applied the above concept to the F-16 initial provisioning process as described below:

- Mature (@ approximately 100,000 flight hours) MTBF values for LRUs were developed via a comparability analysis using a similar equipments on other mature weapons systems.

- The mature MTBF values were factored to generate mature MTBD values. These mature MTBD values are the MTBCT values entered on each F-16 Optimum Repair Level Analysis (ORLA).

- Corrective Task $\approx$ Mature MTBD

- Using the reliability growth concept in reverse, each mature MTBD was "derated" or factored to reflect a less reliable situation early in the operational life of the F-16 (the derate factors varied depending upon the nature of the item). The "derated" values were entered in the ORLA as the "FINAL GOVERNMENT APPROVED" value and, in most cases, on the initial RILSA Data Worksheet used for initial provisioning. The derate factor was based on projected growth curves for MTBF at LRU and subsystem levels. An assumption was made that the growth rate for MTBF (same as MTBM (inherent) today) was the same for MTBD.

Follow-on Provisioning - If the reliability growth assumption (as applied above) is correct, then items should show improvement as operational flight hours are accumulated. To quantify this expected improvement, MMAR developed a series of mini-programs based on the

Duane Postulate which provide the technicians with maintenance factors for the first, second and third forecast periods. These procedures (attachment 1) are not used for all items or in all situations, but are used where deemed applicable by the technician and section supervisor.

Examples - Attachment 4A contains examples of the two most common reliability growth curves. Included are the ORLA, the HP97 printout, a graph of the HP97 data, and a computer generated chart showing relationships between ORLA, D041 projected values, and maintenance data removal rates. Note that the D041 values shown on this chart are based on the initial D041 products and will be changed to reflect the new forecast values when the final D041 products are available.

Source: AFALC/ERR

NSN: 1270010975701UF UUC: 74AD0 DGTL SIG PROCESS

ORLA PROJECTIONS:	MTBD	MAINT FACT
INITIAL	43.00	2.3256
MATURE(100,000. FH)	108.00	0.9259
CURRENT(87800. FH)	105.30	0.9497

D041 DATA (LAST UPDATE: DEC 1981 FINAL)

ITEM	MAINT FACTOR	MTBD
CURRENT FORECAST	0.4558C	219.4
1ST FORECAST	0.4558C	219.4
2ND FORECAST	0.4558C	219.4
3RD FORECAST	0.4558C	219.4
12 MO SUMMARY	0.4372C	228.7

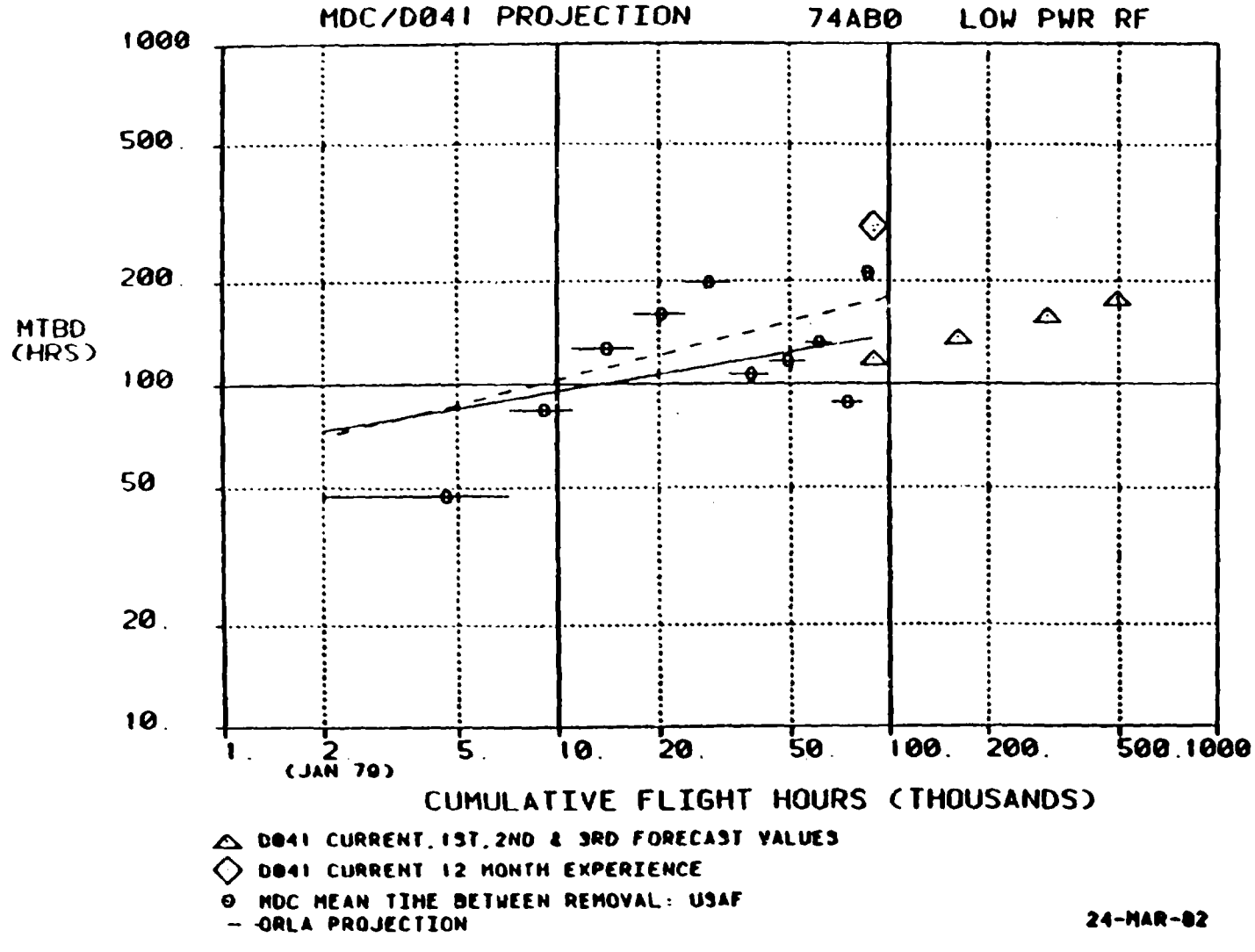
MAINTENANCE DATA : USAF

PERIOD MOS	YR	FHR	QPA FACTOR	NUMBER REMOVALS (TYPE 1&2)	MTBR
1-12	79	5179.	1.00	37	140.0
1-3	80	3863.	1.00	19	203.3
4-6	80	5840.	1.00	27	216.3
7-9	80	7030.	1.00	21	334.8
10-12	80	8682.	1.00	19	456.9
1-3	81	10401.	1.00	40	260.0
4-6	81	12452.	1.00	69	180.5
7-9	81	11337.	1.00	53	213.9
10-12	81	16610.	1.00	37	448.9
1	82	5934.	1.00	11	539.5
SUMMARY OF LAST 4 PERIODS				170	272.5

MDC REGRESSION LINE

SLOPE: 0.26 INTCPT: 17.861 CORR(R): 0.51

CURRENT ESTIMATE: 362.4 MTBD


MDC/D041 PROJECTION 74AB0 LOW PWR RF
1000
500
200
100
50
20
10
MTBD (HRS)
1
2 (JAN 79)
5
10
20
50
100
200
500
1000
CUMULATIVE FLIGHT HOURS (THOUSANDS)
D041 CURRENT, 1ST, 2ND & 3RD FORECAST VALUES
D041 CURRENT 12 MONTH EXPERIENCE
MDC MEAN TIME BETWEEN REMOVAL: USAF
ORLA PROJECTION
24-MAR-82

NSN: 1270011022962UF UUC: 74AB0 LOU PUR RF

ORLA PROJECTIONS:	MTBD	MAINT FACT
INITIAL	71.00	1.4085
MATURE(100,000. FH)	179.00	0.5587
CURRENT(87800. FH)	174.51	0.5730

D041 DATA (LAST UPDATE: DEC 1981 FINAL)

ITEM	MAINT FACTOR	MTBD
CURRENT FORECAST	0.8387E	119.2
1ST FORECAST	0.7292E	137.1
2ND FORECAST	0.6283E	159.2
3RD FORECAST	0.5600E	178.6
12 MO SUMMARY	0.3472C	288.0

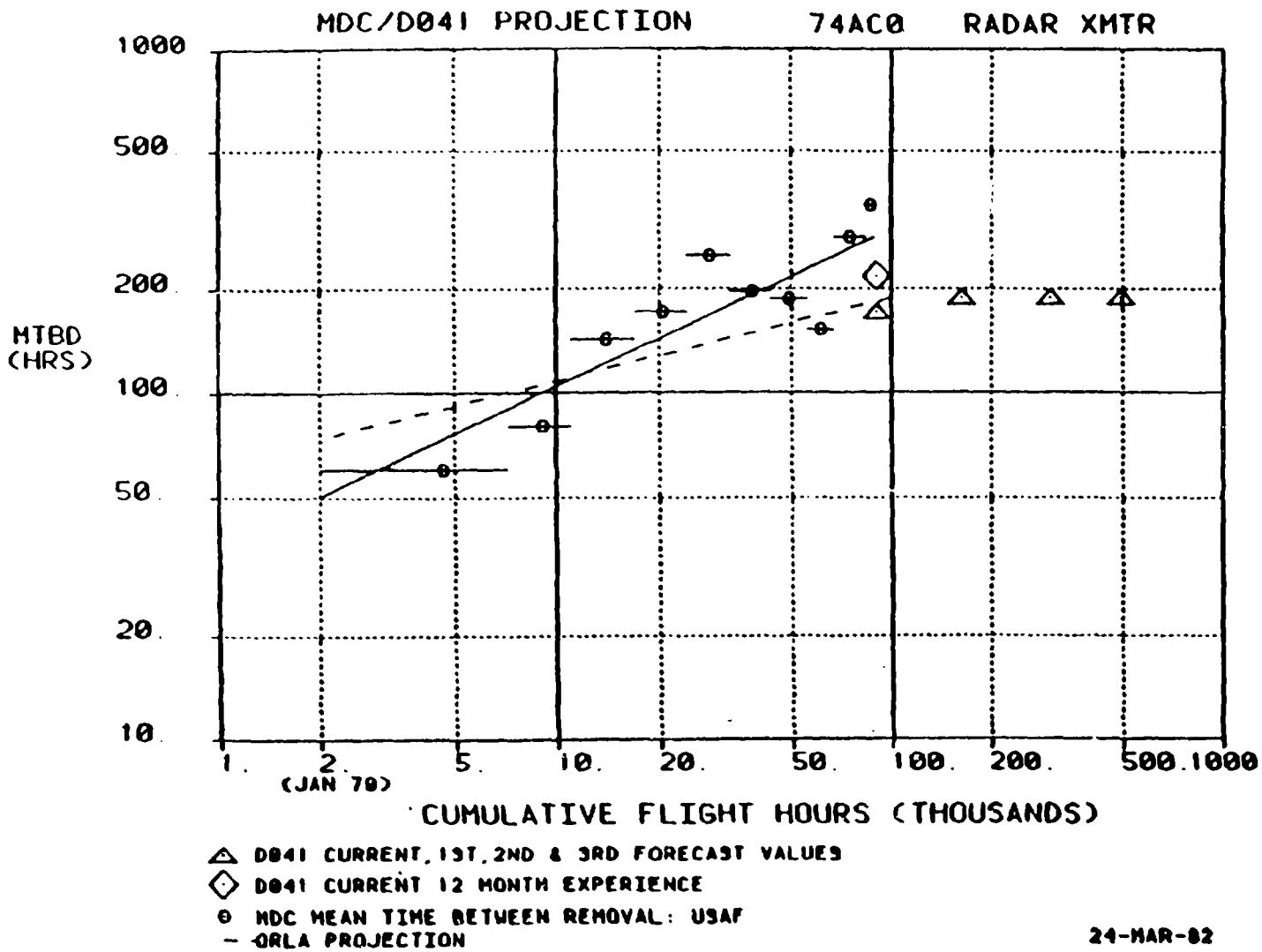
MAINTENANCE DATA : USAF

PERIOD MOS	YR	FHR	QPA FACTOR	NUMBER REMOVALS (TYPE 1&2)	MTBR
1-12	79	5179.	1.00	109	47.5
1-3	80	3863.	1.00	46	84.0
4-6	80	5840.	1.00	46	127.0
7-9	80	7030.	1.00	44	159.8
10-12	80	8682.	1.00	44	197.3
1-3	81	10401.	1.00	97	107.2
4-6	81	12452.	1.00	107	116.4
7-9	81	11337.	1.00	86	131.8
10-12	81	16610.	1.00	188	88.4
1	82	5934.	1.00	28	211.9
SUMMARY OF LAST 4 PERIODS				409	113.3

MDC REGRESSION LINE

SLOPE: 0.16 INTCPT: 21.759 CORR(R): 0.35

CURRENT ESTIMATE: 136.1 MTBD


MDC/D041 PROJECTION
74AC0 RADAR XMTR
1000
500
200
100
50
20
10
MTBD
(HRS)
1.
2.
5.
10.
20.
50.
100.
200.
500.
1000
(JAN 79)
CUMULATIVE FLIGHT HOURS (THOUSANDS)
D041 CURRENT, 1ST, 2ND & 3RD FORECAST VALUES
D041 CURRENT 12 MONTH EXPERIENCE
MDC MEAN TIME BETWEEN REMOVAL: USAF
ORLA PROJECTION
24-MAR-82

NSN: 1270010932256UF UUC: 74AC0 RADAR XMTR

ORLA PROJECTIONS:	MTBD	MAINT FACT
INITIAL	74.00	1.3514
MATURE(100,000. FH)	188.00	0.5319
CURRENT(87800. FH)	183.24	0.5457

D041 DATA (LAST UPDATE: DEC 1981 FINAL)

ITEM	MAINT FACTOR	MTBD
CURRENT FORECAST	0.5866E	170.5
1ST FORECAST	0.5319E	188.0
2ND FORECAST	0.5319E	188.0
3RD FORECAST	0.5319E	188.0
12 MO SUMMARY	0.4584C	218.2

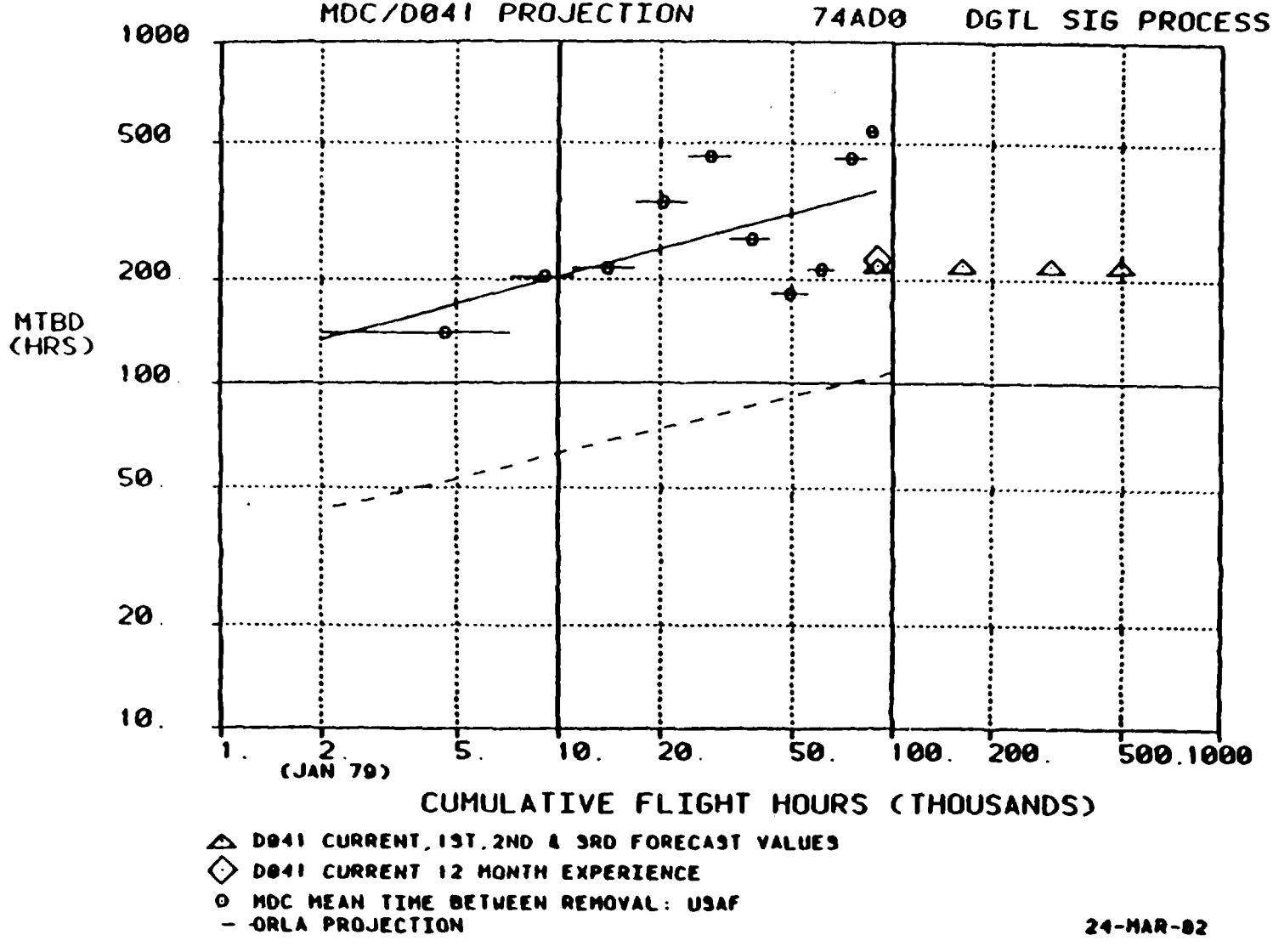
MAINTENANCE DATA : USAF

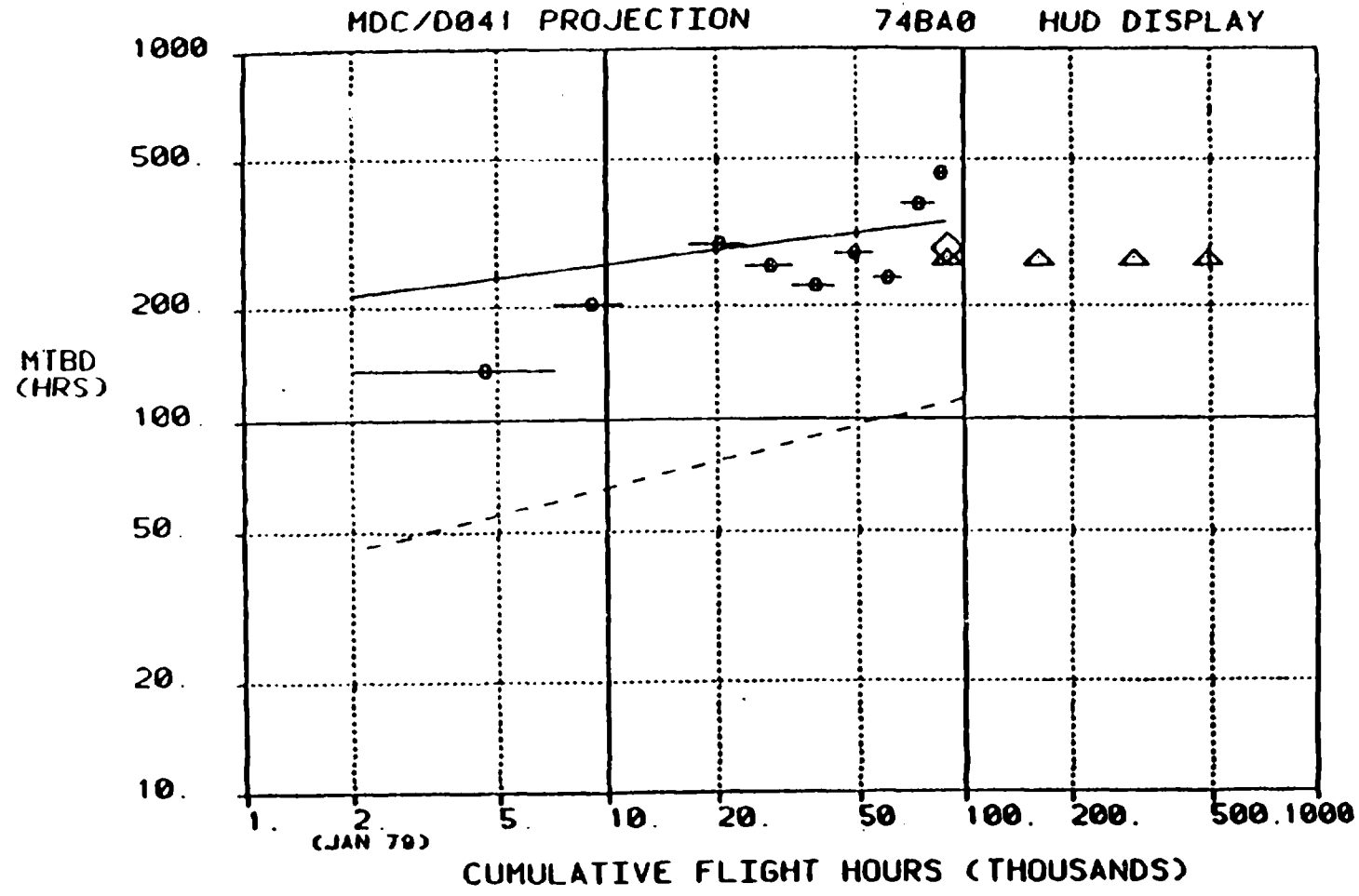
PERIOD MOS	YR	FHR	QPA FACTOR	NUMBER REMOVALS (TYPE 1&2)	MTBR
1-12	79	5179.	1.00	86	60.2
1-3	80	3863.	1.00	48	80.5
4-6	80	5840.	1.00	41	142.4
7-9	80	7030.	1.00	41	171.5
10-12	80	8682.	1.00	35	248.1
1-3	81	10401.	1.00	53	196.2
4-6	81	12452.	1.00	67	185.9
7-9	81	11337.	1.00	74	153.2
10-12	81	16610.	1.00	59	281.5
1	82	5934.	1.00	17	349.1
SUMMARY OF LAST 4 PERIODS				217	213.5

MDC REGRESSION LINE

SLOPE: 0.45 INTCPT: 1.656 CORR(R): 0.83

CURRENT ESTIMATE: 280.6 MTBD


MDC/D041 PROJECTION
74AD0 DGTL SIG PROCESS
1000
500
200
100
50
20
10
MTBD
(HRS)
1.
2.
(JAN 79)
5.
10.
20.
50.
100.
200.
500.
1000
CUMULATIVE FLIGHT HOURS (THOUSANDS)
D041 CURRENT, 1ST, 2ND & 3RD FORECAST VALUES
D041 CURRENT 12 MONTH EXPERIENCE
MDC MEAN TIME BETWEEN REMOVAL: USAF
- ORLA PROJECTION
24-MAR-82


MDC/D041 PROJECTION 74BA0 HUD DISPLAY
1000
500.
200.
100.
50.
20.
10.
MTBD
(HRS)
1.
2
(JAN 79)
5.
10.
20.
50
100.
200.
500.
1000
CUMULATIVE FLIGHT HOURS (THOUSANDS)
△ D041 CURRENT, 1ST, 2ND & 3RD FORECAST VALUES
◇ D041 CURRENT 12 MONTH EXPERIENCE
MDC MEAN TIME BETWEEN REMOVAL: USAF
– ORLA PROJECTION
24-MAR-82

NSN: 6605010948505UF UUC: 74BA0 HUD DISPLAY

ORLA PROJECTIONS:	MTBD	MAINT FACT
INITIAL	45.00	2.2222
MATURE(100,000. FH)	113.00	0.8850
CURRENT(87800. FH)	110.17	0.9076

D041 DATA (LAST UPDATE: DEC 1981 FINAL)

ITEM	MAINT FACTOR	MTBD
CURRENT FORECAST	0.3733C	267.9
1ST FORECAST	0.3733C	267.9
2ND FORECAST	0.3733C	267.9
3RD FORECAST	0.3733C	267.9
12 MO SUMMARY	0.3504C	285.4

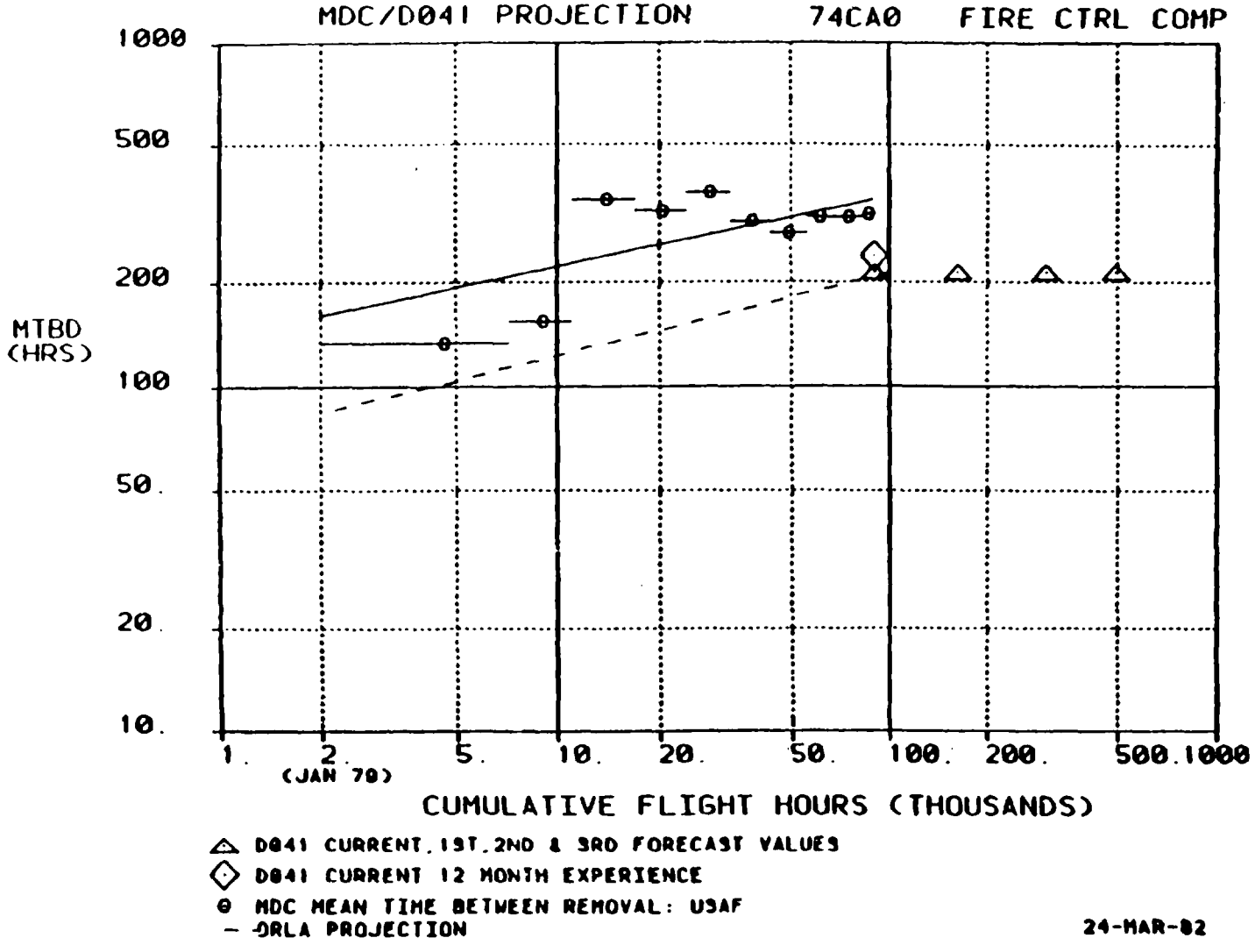
MAINTENANCE DATA : USAF

PERIOD MOS	YR	FHR	QPA FACTOR	NUMBER REMOVALS (TYPE 1&2)	MTBR
1-12	79	5179.	1.00	38	136.3
1-3	80	3863.	1.00	19	203.3
4-6	80	5840.	1.00	5	1168.0
7-9	80	7030.	1.00	24	292.9
10-12	80	8682.	1.00	34	255.4
1-3	81	10401.	1.00	46	226.1
4-6	81	12452.	1.00	45	276.7
7-9	81	11337.	1.00	48	236.2
10-12	81	16610.	1.00	44	377.5
1	82	5934.	1.00	13	456.5
SUMMARY OF LAST 4 PERIODS				150	308.9

MDC REGRESSION LINE

SLOPE: 0.12 INTCPT: 87.873 CORR(R): 0.20

CURRENT ESTIMATE: 335.4 MTBD


MDC/D041 PROJECTION
74CA0 FIRE CTRL COMP
1000
500
200
100
50.
20.
10.
MTBD
(HRS)
1.
2.
(JAN 79)
5.
10.
20.
50.
100.
200.
500.
1000
CUMULATIVE FLIGHT HOURS (THOUSANDS)
D041 CURRENT, 1ST, 2ND & 3RD FORECAST VALUES
D041 CURRENT 12 MONTH EXPERIENCE
MDC MEAN TIME BETWEEN REMOVAL: USAF
ORLA PROJECTION
24-MAR-82

NSN: 1270010453976UF UUC: 74CA0 FIRE CTRL COMP

ORLA PROJECTIONS:	MTBD	MAINT FACT
INITIAL	84.00	1.1905
MATURE(100,000. FH)	214.00	0.4673
CURRENT(87800. FH)	208.57	0.4795

D041 DATA (LAST UPDATE: DEC 1981 FINAL)

ITEM	MAINT FACTOR	MTBD
CURRENT FORECAST	0.4673F	214.0
1ST FORECAST	0.4673E	214.0
2ND FORECAST	0.4673E	214.0
3RD FORECAST	0.4673E	214.0
12 MO SUMMARY	0.4230C	236.4

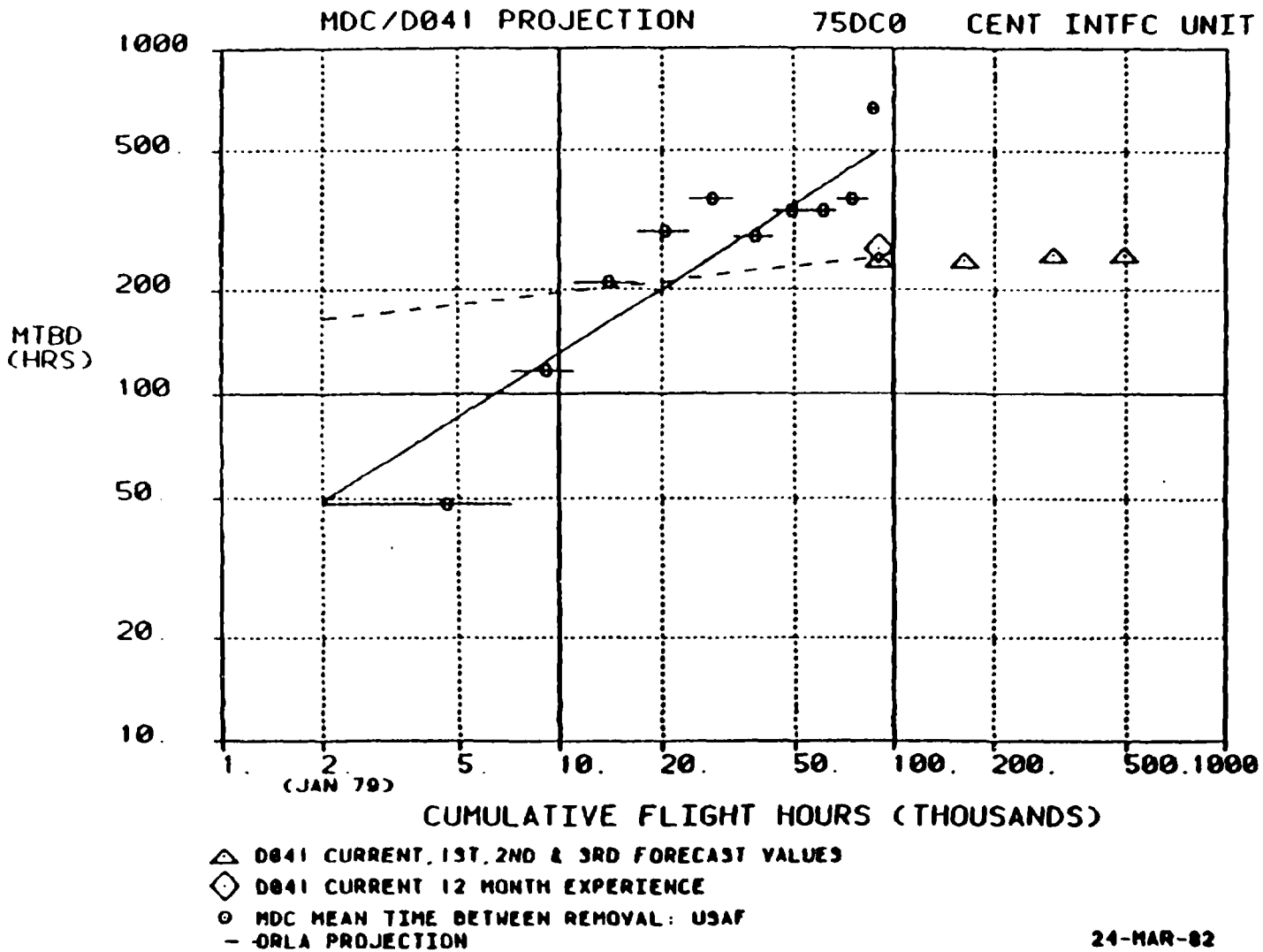
MAINTENANCE DATA : USAF

PERIOD MOS	YR	FHR	QPA FACTOR	NUMBER REMOVALS (TYPE 1&2)	MTBR
1-12	79	5179.	1.00	39	132.8
1-3	80	3863.	1.00	25	154.5
4-6	80	5840.	1.00	17	343.5
7-9	80	7030.	1.00	22	319.5
10-12	80	8682.	1.00	24	361.8
1-3	81	10401.	1.00	35	297.2
4-6	81	12452.	1.00	45	276.7
7-9	81	11337.	1.00	37	306.4
10-12	81	16610.	1.00	54	307.6
1	82	5934.	1.00	19	312.3
SUMMARY OF LAST 4 PERIODS				155	298.9

MDC REGRESSION LINE

SLOPE: 0.20 INTCPT: 34.383 CORR(R): 0.64

CURRENT ESTIMATE: 343.6 MTBD


MDC/D041 PROJECTION
75DC0 CENT INTFC UNIT
1000
500
200
100
50
20
10
MTBD
(HRS)
1
2
(JAN 79)
5
10.
20.
50.
100.
200.
500.
1000
CUMULATIVE FLIGHT HOURS (THOUSANDS)
D041 CURRENT, 1ST, 2ND & 3RD FORECAST VALUES
D041 CURRENT 12 MONTH EXPERIENCE
MDC MEAN TIME BETWEEN REMOVAL: USAF
ORLA PROJECTION
24-MAR-82

NSN: 1280011096916WF WUC: 75DC0 CENT INTFC UNIT

ORLA PROJECTIONS:	MTBD	MAINT FACT
INITIAL	164.00	0.6098
MATURE(100,000. FH)	250.00	0.4000
CURRENT(87800. FH)	247.12	0.4047

D041 DATA (LAST UPDATE: DEC 1981 FINAL)

ITEM	MAINT FACTOR	MTBD
CURRENT FORECAST	0.4145C	241.3
1ST FORECAST	0.4145C	241.3
2ND FORECAST	0.4000E	250.0
3RD FORECAST	0.4000E	250.0
12 MO SUMMARY	0.3823C	261.6

MAINTENANCE DATA : USAF

PERIOD MOS	YR	FHR	QPA FACTOR	NUMBER REMOVALS (TYPE 1&2)	MTBR
1-12	79	5179.	1.00	107	48.4
1-3	80	3863.	1.00	33	117.1
4-6	80	5840.	1.00	28	208.6
7-9	80	7030.	1.00	24	292.9
10-12	80	8682.	1.00	24	361.8
1-3	81	10401.	1.00	37	281.1
4-6	81	12452.	1.00	37	336.5
7-9	81	11337.	1.00	34	333.4
10-12	81	16610.	1.00	46	361.1
1	82	5934.	1.00	9	659.3
SUMMARY OF LAST 4 PERIODS				126	367.7

MDC REGRESSION LINE

SLOPE: 0.61 INTCPT: 0.485 CORR(R): 0.88

CURRENT ESTIMATE: 497.0 MTBD

APPENDIX D: RELIABILITY GROWTH PROCEDURES

D041 GROWTH/PROJECTION CURVE PROCEDURES

1. ASSUMPTIONS:

   a. Reliability growth is described through a mathematical function which can be plotted as a straight line on log-log graph paper (Duane Postulate).

   b. In general, mature reliability is achieved at approximately 100,000 FH. (Individual items will obviously mature at different points of time.)

   c. The initial baseline growth rate (reference paragraph 2b below) is the maximum rate expected.

   d. The contractor MTBCT (mature MTBD) is the maximum value expected.

   e. Production equipment growth curves begin at the 2000 FH (end of FSD) point on the curve. This point is equivalent to "0" production aircraft FH.

2. PROCEDURES:

   a. On a quarterly basis, the reliability engineer determines the projected FH values for the beginning of the 1st, 2nd, and 3rd forecast periods using PA/D041 values. Two thousand (2000) Fh are added to each value to compensate for starting the growth curves at 2000 FH.

   b. The baseline growth curve is constructed using "FINAL GOVERNMENT APPROVED" ORLA maintenance factor (at 2000 FH) and the contractor MTBCT value (at 100,000 FH).

   c. The current projected value ("P") for MTBD is extracted from the baseline curve at the end-of-quarter cumulative FH + 2000 FH point.

   d. Using all data, knowledge, experience, etc., available, the technician estimates the current MTBD ("E") of the item.

   e. The applicable growth techniques are applied using the following criteria:

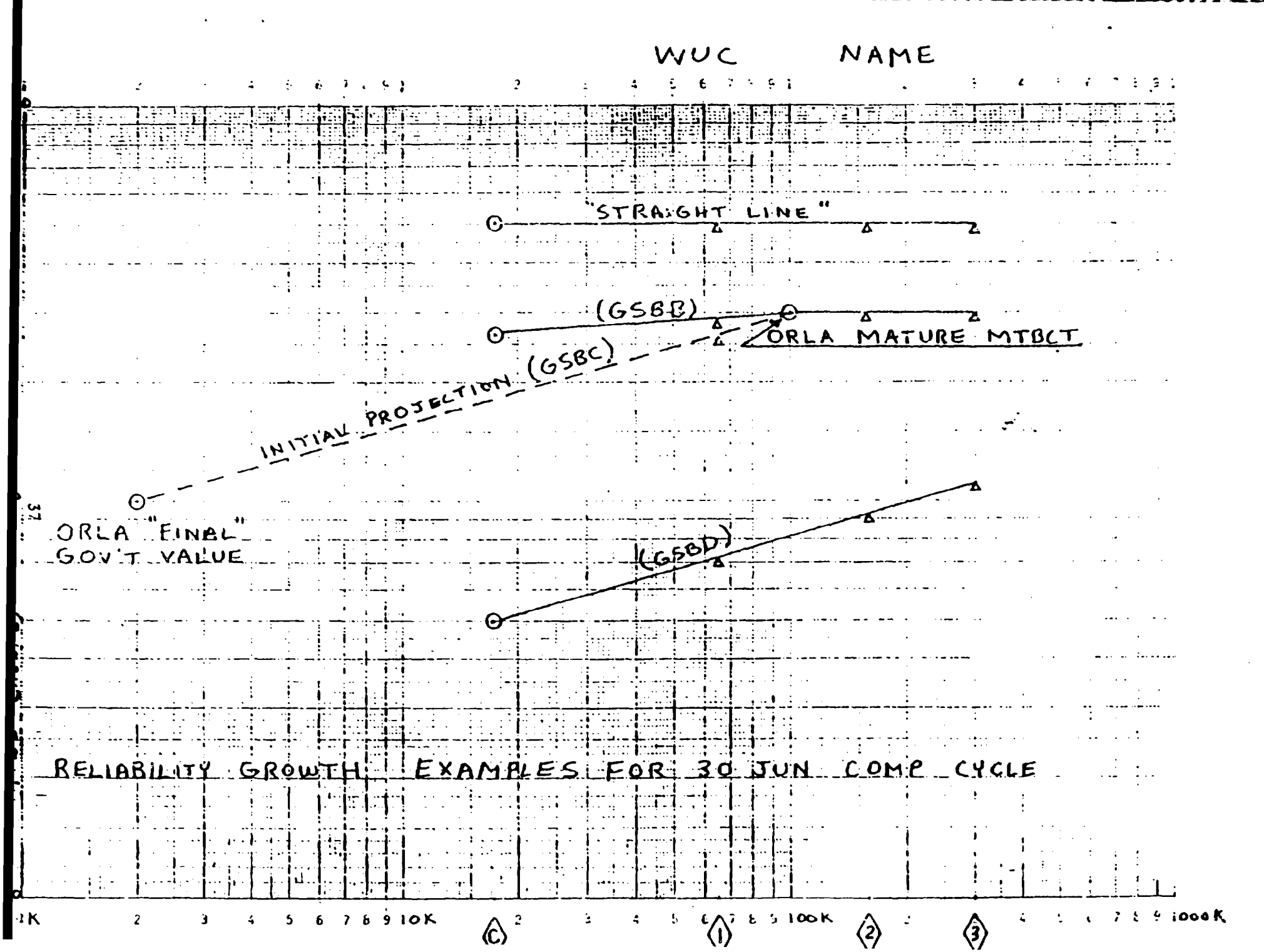
      (1) If "E" is greater than MTBCT, use "E" as the value for current, 1st, 2nd, and 3rd forecasts.

(2) If "E" is greater than "P", but less than MTBCT, construct a new projected line from the "E" value (at current FL plus 2000) to MTBCT.

(3) If "E" is less than "P", construct a line parallel to the baseline growth curve, beginning at the "E" value and current FH plus 2000 FH. Continue the line to the MTBCT value or the value corresponding to the 3rd forecast FH, whichever occurs first.

f. The corresponding 1st, 2nd and 3rd forecast MTBD values are extracted from the curve generated in paragraph 2e above. These MTBD values are then converted to maintenance factors.

g. The computations referenced in 2b, 2c, 2e and 2f are automated via a program which is run on the HP97 calculator.


WUC NAME
"STRAIGHT LINE"
(GSBB)
ORLA MATURE MTBCT
INITIAL PROJECTION (GSBC)
ORLA "FINAL"
GOV'T VALUE
(GSBD)
RELIABILITY GROWTH EXAMPLES FOR 30 JUN COMP CYCLE
1K
2
3
4
5
6
7
8
9
10K
100K
1000K
(C)
(1)
(2)
(3)

APPENDIX E: R&M TRACKING SCREENS AND REPORT FORMATS

R&M1 UDB 2000 LSAR DATA SCREEN
R&M TRACKING DATA

DATE __/__/__
TIME __:__:__
USER _____

END ITEM ACRONYM CODE: _____

	MTBF (HRS)	MMH/FH (ORG LVL)	FMC
PREDECESSOR:			
USER REQUIREMENT:	_____._	___.__	__.__
NEW SYSTEM:			
USER REQUIREMENT:	_____._	___.__	__.__
PDM VALUE:	_____._	___.__	__.__
CONT REQUIREMENT:	_____._	___.__	__.__
THRESHOLD VALUE:	_____._	___.__	__.__

DATE/USER LAST UPDATE: _____ _____

R&M2

UDB 2000 LSAR DATA SCREEN
R&M TRACKING DATA

DATE __/__/__
TIME __:__:__
USER _____

END ITEM ACRONYM CODE: _____

ACQUISITION PHASE:	DATE BEGINNING	DATE ENDING
CONCEPT:	__/__/__	__/__/__
DEMONSTRATION/VALIDATION:	__/__/__	__/__/__
FULL SCALE DEVELOPMENT:	__/__/__	__/__/__
PRODUCTION:	__/__/__	__/__/__

	DATE
CRITICAL DESIGN REVIEW:	__/__/__
FIRST FLIGHT:	__/__/__
PRODUCTION DECISION	__/__/__
IOC:	__/__/__
START TESTING:	__/__/__

DATE/USER LAST UPDATE: _____ _____

R&M3 UDB 2000 LSAR DATA SCREEN
R&M TRACKING DATA

DATE __/__/__
TIME __:__:__
USER _____

END ITEM ACRONYM CODE: _____

NEW SYSTEM:
PROJECTED/PREDICTED VALUES:

TYPE OF TEST	DATE	CUM FLT HRS	MTBF(HRS)	MMH/FH (ORG LVL)	FMC
_____	__/__/__	_____	_____._	____.__	__.__
_____	__/__/__	_____	_____._	____.__	__.__
_____	__/__/__	_____	_____._	____.__	__.__
_____	__/__/__	_____	_____._	____.__	__.__
_____	__/__/__	_____	_____._	____.__	__.__
_____	__/__/__	_____	_____._	____.__	__.__
_____	__/__/__	_____	_____._	____.__	__.__
_____	__/__/__	_____	_____._	____.__	__.__
_____	__/__/__	_____	_____._	____.__	__.__

DATE/USER LAST UPDATE: _____ _____

R&M4

UDB 2000 LSAR DATA SCREEN
R&M TRACKING DATA

DATE __/__/__
TIME __:__:__
USER ______

END ITEM ACRONYM CODE: ________

NEW SYSTEM:
DEMO/TESTED VALUES:

TYPE OF TEST	DATE	CUM FLT HRS	MTBF(HRS)	MMH/FH (ORG LVL)	FMC
________	__/__/__	____	______._	____.___	__.__
________	__/__/__	____	______._	____.___	__.__
________	__/__/__	____	______._	____.___	__.__
________	__/__/__	____	______._	____.___	__.__
________	__/__/__	____	______._	____.___	__.__
________	__/__/__	____	______._	____.___	__.__
________	__/__/__	____	______._	____.___	__.__
________	__/__/__	____	______._	____.___	__.__
________	__/__/__	____	______._	____.___	__.__

DATE/USER LAST UPDATE: ______ ______

R&M5 UDB 2000 LSAR DATA SCREEN
R&M TRACKING DATA

DATE __/__/__
TIME __:__:__
USER _____

END ITEM ACRONYM CODE: _____

	MTBF(HRS)	MMH/FH (ORG LVL)	FMC
PREDECESSOR: FIELD/ACTUAL VALUE:	_____._	____.__	__.__

NEW SYSTEM:
FIELD/ACTUAL VALUE:

TYPE OF TEST	DATE	CUM FLT HRS	MTBF(HRS)	MMH/FH (ORG LVL)	FMC
_____	__/__/__	_____	_____._	____.__	__.__
_____	__/__/__	_____	_____._	____.__	__.__
_____	__/__/__	_____	_____._	____.__	__.__
_____	__/__/__	_____	_____._	____.__	__.__
_____	__/__/__	_____	_____._	____.__	__.__
_____	__/__/__	_____	_____._	____.__	__.__

DATE/USER LAST UPDATE: _____ _____

R&M6 UDB 2000 LSAR DATA SCREEN
R&M TRACKING DATA

DATE __/__/__
TIME __:__:__
USER _____

END ITEM ACRONYM CODE: _____

MTBF GROWTH:

TYPE OF TEST	DATE __/__/__	CUM FLT HRS	PLANNED GROWTH	PROJECTED GROWTH
_____	__/__/__	_____	__.__	__.__
_____	__/__/__	_____	__.__	__.__
_____	__/__/__	_____	__.__	__.__
_____	__/__/__	_____	__.__	__.__
_____	__/__/__	_____	__.__	__.__
_____	__/__/__	_____	__.__	__.__
_____	__/__/__	_____	__.__	__.__
_____	__/__/__	_____	__.__	__.__
_____	__/__/__	_____	__.__	__.__
_____	__/__/__	_____	__.__	__.__

DATE/USER LAST UPDATE: _____ _____

R&M PROGRAM AUDIT TRAIL REPORT

R&M AUD CONT __ ACCY __ LOGISTIC SUPPORT ANALYSIS RECORD __/__/__ PAGE __
RELIABILITY AND MAINTAINABILITY PROGRAM AUDIT TRAIL

EIAC ITEM NAME

REQUIREMENTS:	MTBF(HRS)	BM ASSESS	MMH/FH (ORG LVL)	BM ASSESS	BMC	BM ASSESS
USER REQUIREMENTS (PREDECESSOR):	____._	_	___.__	_	__.__	_
USER REQUIREMENTS (NEW):	____._	_	___.__	_	__.__	_
FDM VALUE:	____._	_	___.__	_	__.__	_
CONTRACTUAL REQUIREMENTS:	____._	_	___.__	_	__.__	_
FIELD VALUE (PREDECESSOR):	____._	_	___.__	_	__.__	_

TRACKING DATA:

PROJECTED/PREDICTED VALUES:

DATE	MTBF(HRS)	BM ASSESS	MMH/FH (ORG LVL)	BM ASSESS	BMC	BM ASSESS
__/__/__	____._	_	___.__	_	__.__	_
__/__/__	____._	_	___.__	_	__.__	_

DEMO/TEST VALUES:

DATE	MTBF(HRS)	BM ASSESS	MMH/FH (ORG LVL)	BM ASSESS	BMC	BM ASSESS
__/__/__	____._	_	___.__	_	__.__	_
__/__/__	____._	_	___.__	_	__.__	_

FIELD/ACTUAL VALUES

DATE	MTBF(HRS)	BM ASSESS	MMH/FH (ORG LVL)	BM ASSESS	BMC	BM ASSESS
__/__/__	____._	_	___.__	_	__.__	_
__/__/__	____._	_	___.__	_	__.__	_

RELIABILITY MANAGEMENT CHART DATA REPORT

RMC-DATA CONT __ AGCY __ LOGISTIC SUPPORT ANALYSIS RECORD RELIABILITY MANAGEMENT CHART DATA __/__/__ PAGE __

EIAC _____ ITEM NAME _____

ACQUISITION PHASE:	DATE BEGINNING:	DATE ENDING:	MILESTONES:	DATE
CONCEPT:	__/__/__	__/__/__	CRITICAL DESIGN REVIEW:	__/__/__
DEMONSTRATION/VALIDATION:	__/__/__	__/__/__	FIRST FLIGHT:	__/__/__
FULL SCALE DEVELOPMENT:	__/__/__	__/__/__	PRODUCTION DECISION:	__/__/__
PRODUCTION:	__/__/__	__/__/__	IOC:	__/__/__

REQUIREMENTS:	DATE	MTBF (HRS)
THRESHOLD VALUE:	__/__/__	____._
CONTRACTUAL REQUIREMENTS:	__/__/__	____._

TRACKING DATA:

TYPE OF TEST	DATE	CUMULATIVE FLIGHT HOURS	PREDICTED MTBF (HRS)	ACTUAL MTBF (HRS)	PLANNED GROWTH	PROJECTED GROWTH
START TESTING	__/__/__	00000	____._	____._	__._	__._
_____	__/__/__	____	____._	____._	__._	__._
_____	__/__/__	____	____._	____._	__._	__._
_____	__/__/__	____	____._	____._	__._	__._
	/ /					

REFERENCES

Air Force Regulations:

AFR 800-5 — Acquisition Management, Selected Acquisition Reports (SARs), dated 18 March 1976.

AFR 800-18 — Acquisition Management, Air Force Reliability and Maintainability Program, dated 15 June 1982.

AFLC Supplement 1 to AFR 800-18, dated 10 May 1983.

Military Standards:

MIL-STD-470A — Maintainability Program For Systems & Equipment, dated 3 January 1983.

MIL-STD-721B — Definitions of Effectiveness Terms For Reliability, Maintainability, Human Factors, and Safety, dated 25 August 1966, Revised 10 March 1970.

MIL-STD-756B — Reliability Modeling and Prediction, dated 18 November 1981.

MIL-STD-785B — Reliability Program For Systems and Equipment Development and Production, dated 15 September 1980.

MIL-STD-1388-1A — Weapon System and Equipment Support Analysis, dated November 1981.

MIL-STD-1388-2A — DoD Requirements For a Logistic Support Analysis Record, dated July 1984 and Notice 1, dated 14 February 1986.

MIL-STD-1629A — Procedures For Performing a Failure Mode, Effects and Criticality Analysis, dated 24 November 1980.

MIL-HDBK-217D — Reliability Prediction of Electronic Equipment, dated 15 January 1982.

NOTE: All of the reference documents are currently on file at ISS.

GLOSSARY

AFALC	-	Air Force Acquisition Logistics Center
AFLC	-	Air Force Logistics Command
AFSARC	-	Air Force Systems Acquisition Review Council
ALC	-	Aerospace Logistics Center
CAR	-	Contractor Assessment Review
CDR	-	Critical Design Review
CY	-	Calendar Year
DoD	-	Department of Defense
DSARC	-	Defense Systems Acquisition Review Council
FMC	-	Full Mission Capable
FSD	-	Full-Scale Development
HQAFSC	-	Headquarters, Air Force Systems Command
HQUSAF	-	Headquarters, United States Air Force
IOC	-	Initial Operational Capability
IOT&E	-	Initial Operational Test and Evaluation
LRU	-	Line Replaceable Unit
LSA	-	Logistic Support Analysis
LSAR	-	Logistic Support Analysis Record
MDC	-	Maintenance Data Collection
MMH/FH	-	Maintenance Manhours per Flight Hour
MTBF	-	Mean Time Between Failure
MTBD	-	Mean Time Between Demand
MTBM	-	Mean Time Between Maintenance
MTBR	-	Mean Time Between Removal
OPR	-	Office of Primary Responsibility
ORLA	-	Optimum Repair Level Analysis
OT&E	-	Operational Test and Evaluation
PAR	-	Program Assessment Review
PM	-	Program Manager
PMD	-	Program Management Directive
RAM	-	Reliability (R), Availability (A), and Maintainability (M)
RCS	-	Reports Control Symbol
REMIS	-	Reliability and Maintainability Information System
RQT	-	Reliability Qualification Test
R&M	-	Reliability (R) and Maintainability (M)
SON	-	Statement of Need
SPR	-	Special Program Review
SRU	-	Shop Replaceable Unit
UDB	-	Unified Data Base

END

DATE

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